

"ENERGY AUDITS": The Key to Performance Contracting Projects

Mahesh Tharoor
Energy Consultant
Johnson Controls
Irving, TX

ABSTRACT

The term "Performance Contracting" relates to projects where the performance of various energy conservation retrofits result in savings that exceed the implementation cost of the entire project when financed over a fixed term. Such projects minimize the risk to the customer by guaranteeing a fixed annual return on the investment. If the specified guarantee amount is not met annually, the respective energy service company writes a check to account for the difference in the savings shortfall.

Energy Auditing is a key tool in implementing performance contracting projects. The audit allows for studying the condition of all existing equipment and their operation, and more importantly determines the feasibility of implementing energy conservation retrofits and practices. All inputs for calculating energy savings, and the design of energy conservation measures are dependent on the audit. Since performance contracting projects are guaranteed over several years, any mistake or short sightedness on the part of the audit team in either gathering information or calculating energy savings can result in severe liability on part of the energy service company.

This paper explores the key aspects of energy audits in performance contracting type of projects. Examples of audits in various markets, and its impact on performance guarantee and monitoring will be discussed.

ENERGY AUDITING

The term "Energy Audit" is widely used in numerous texts, publications, and seminars. This general term refers to, at a minimum, conducting an on-site facility survey. Some surveys are conducted to study building energy utilization and equipment maintenance procedures,

while others focus on retrofit feasibility and energy savings potential or general data gathering for cost estimation. Each survey can vary in nature and complexity depending on its purpose.

Energy Auditing is the most important process in evaluating and implementing a Performance Contracting (PC) project. It is a systematic approach developed to understand:

- a) How various forms of energy are consumed and utilized in a facility?
- b) How the different equipment in the facility consume this energy?
- c) How these equipment are maintained and controlled?
- d) What opportunities exist in improving equipment performance or in the reduction of energy usage or utility bills?
- e) Finally, what action is required to achieve the desired improved performance or reduction in utility bills?

The audit process should address the above mentioned steps while incorporating customer issues/needs. Since PC differs from traditional construction/retrofit projects, a systematic and comprehensive audit process is very essential. This process can be summarized as follows:

- Step 1: Utility Analysis [Evaluate]**
- Step 2: Preliminary Energy Audit [Investigate]**
- Step 3: Detailed Energy Audit [Validate]**
- Step 4: Installation [Implement]**
- Step 5: Performance Monitoring and Feedback [Navigate]**

There are no short-cuts or estimating guess work when dealing with PC projects. If an energy service company utilizes a rough estimate in calculating project costs and savings and expects a quick turnaround job, these multi-year guaranteed projects usually end up haunting them down the road. It is therefore very essential that PC projects are handled in a cautious and thorough manner when approaching each stage of the project, delegating the right qualified personnel to the assigned job.

Step1: Utility Analysis [EVALUATE]

Purpose.

The purpose of this task is to evaluate the utility bills in order to identify major fuel types, its impact on utility dollars, patterns of fuel use, correlation with weather patterns, peak usage, and overall building potential for energy savings. If multiple buildings types and meters are involved, a separate analysis should be performed for each building. Figures 1-3, give an example of various graphs that can be effectively generated to study 1) Utility Breakdown, 2) Weather Correlation, and 3) Energy Utilization.

Task.

Some of the key items to be covered in this very important task are as follows:

- Gather 3 year utility data
- Identify types of fuel used and annual utility dollars
- Study patterns of fuel use by fuel type
- Understand utility rate structure
- Analyze demand profiles if on demand rate structure
- Analyze effect of weather on fuel consumption
- Perform utility analysis by building type and size; E.g. \$/sqft, KWH/sqft, MCF/sqft, BTU/sqft, etc.

Result.

This step should answer the following questions:

- What is the unit cost of each fuel type?

- What has been the historical consumption pattern?
- Which fuel type accounts for the largest use and when do they peak?
- When does the facility register its peak demand?
- Is the facility getting penalized for demand? How much?
- Which building utilizes the most energy?
- Can the facility purchase cheaper fuel?

The above information is utilized to prepare the audit team perform a preliminary audit of the facilities. Specific information obtained from analyzing the utility bills is of utmost importance when recommending specific building energy conservation measures, and understanding how the measure will impact the customers' utility bill.

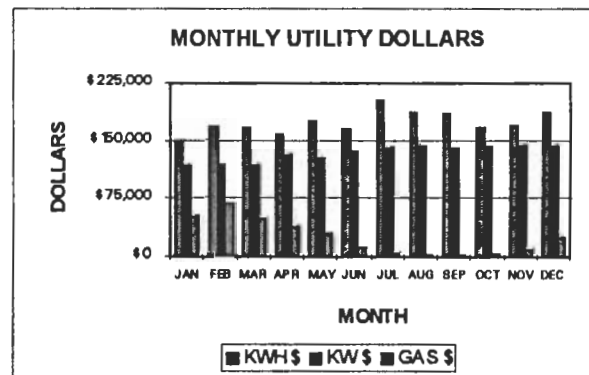


Figure 1 Utility Breakdown

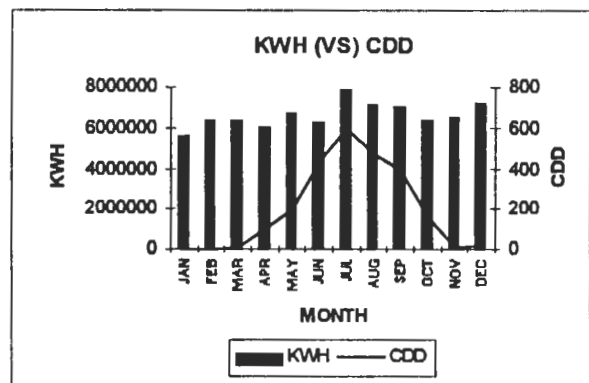


Figure 2a Weather Correlation - KWH

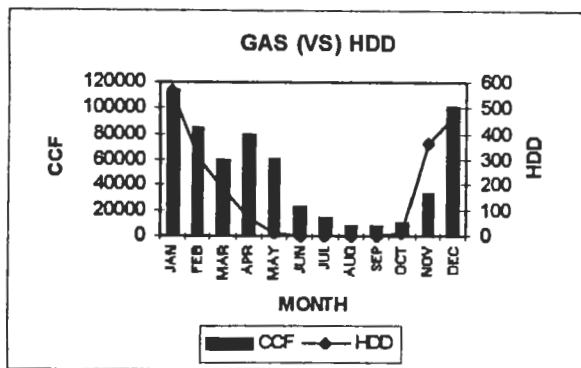


Figure 2b Weather Correlation - Gas

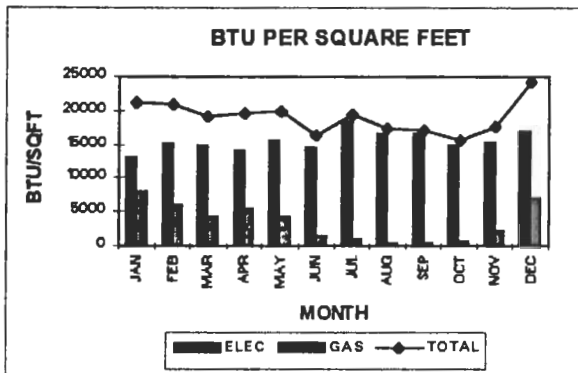


Figure 3 Energy Utilization

Step 2: Preliminary Energy Audit [INVESTIGATE]

Purpose.

The preliminary energy audit is the investigation stage which familiarizes the audit team to the facility, its major energy consuming equipment and their operation. This step identifies and qualifies all areas within the facility needing improvement which would result in energy savings. This audit is the premises for studying the potential for performance contracting.

Task.

Specific questions that need to be addressed at this stage include:

- Are the major energy consuming equipment performing at desired expectation levels?
- Does HVAC operation follow occupancy levels? Are there controls in place to schedule equipment operation?

- What lighting technology is presently utilized, and what light levels are currently maintained?
- What are the customer concerns and needs?
- What are the present operating and maintenance procedures?
- Are there any special purpose equipment or critical operations?
- What are the occupancy, equipment, and lighting hours of operation?

Result.

The Preliminary Energy Audit will provide the energy service company a quick estimate of potential energy savings available and feasibility for performance contracting. It is very important to clearly identify at this stage if the facility is a candidate for performance contracting based on customer expectations and potential energy savings. Otherwise, large amounts of time and money can be wasted, while providing the customer with unrealistic expectations.

Step 3: Detailed Energy Audit [VALIDATE]

Purpose.

The Detailed Energy Audit is the heart of performance contracting projects. It validates the findings of step 2 and information obtained from this audit is utilized to generate final scope of project, designing of proposed retrofits, building simulation models to determine energy savings, generating utility baseline, preparing bid packets, procuring best financing available, testing retrofits, identifying utility rebates, energy savings, and cost of the retrofits. Extensive analysis, testing, and evaluation of HVAC equipment, environmental controls, building envelope, and lighting systems is performed.

Task.

The task of the audit team at this stage is specific, detailed, and time consuming. Due to the savings guarantee involved in performance contracting projects, accurate and detailed measurements and testing of equipment, and gathering of

information is essential. Some of the tasks are outlined below:

- a) Review preliminary audit findings
- b) Obtain and review architectural, mechanical, electrical and control drawings
- c) Prepare site specific survey forms
- d) Perform on-site survey of HVAC equipment, environmental controls, building envelope, and lighting system
- e) Inspect, test, and evaluate facility equipment and operations for efficiency, performance, and reliability
- f) Obtain all occupancy and operating schedules of equipment
- g) Prepare a comprehensive list of Energy Conservation Measures
- h) Gather all pertaining information for analyzing energy conservation measures in order to calculate potential energy savings. This information is typically analyzed utilizing a computer simulation package and may require inputs such as system type, HP, CFM, area served, wall, roof, people, lighting loads, infiltration etc.
- i) Estimate costs to implement energy conservation retrofits
- j) Perform financial analysis and show annual cash flow resulting from recommended retrofits. Other financial measures such as payback, net present value, internal rate of return, and benefit-cost ratio can be performed on the cash flow.

Result.

A report is generated from the audit identifying the various Energy Conservation Measures (ECMs) and their benefits. A utility baseline is also generated. Breakdown of utility savings, guarantee amount, and terms of the performance contract are detailed in the report. Figures 4-7 show examples of audit results generated from projects in various markets. It can be seen that Lighting and Energy Management System retrofits account for the highest percentage of savings in the education and municipal markets. This may not be true in the

industrial and healthcare markets where significant loads are present.

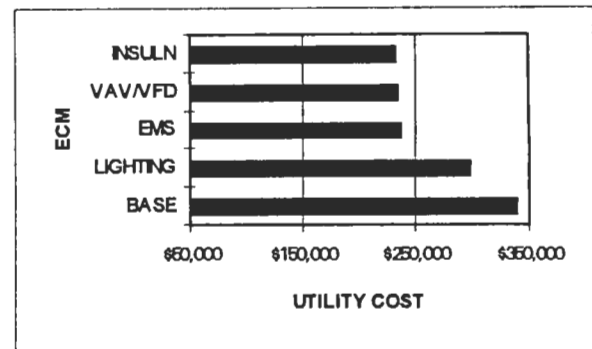


Figure 4 Educational Facility

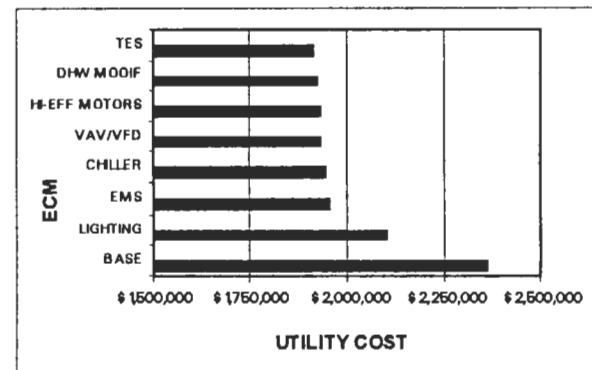


Figure 5 Municipal Facility

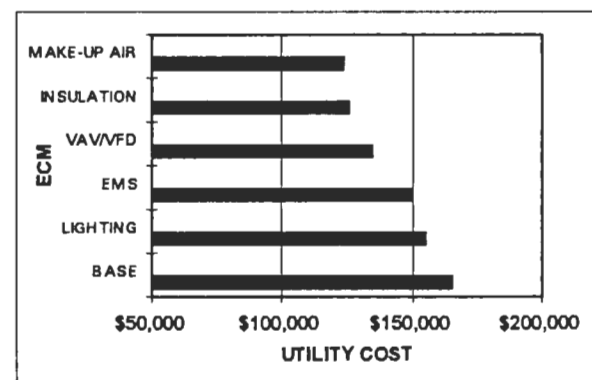


Figure 6 Healthcare Facility

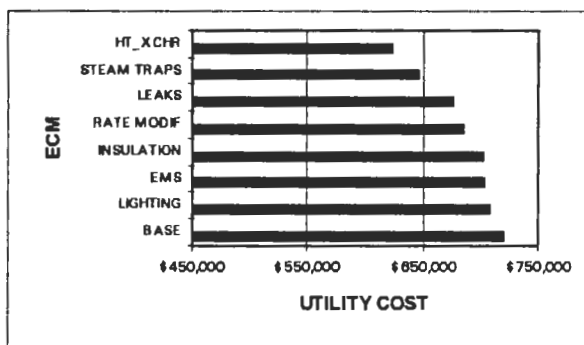


Figure 7 Industrial Facility

**Steps 4 & 5: Installation,
Performance Monitoring & Feedback
[IMPLEMENT & NAVIGATE]**

The success of the energy audit and the project will depend on, how vital information is communicated between the audit team and the implementation team. It is very critical that the implementation team understand exactly what was intended when specific ECMs were recommended. Any modification of the energy retrofits during installation should be communicated back to the audit team, so that the effect on savings can be analyzed. Since the mindset of the implementation team may differ from that of the audit team, it is critical that a Project Manager (PM) be assigned to the project during the detailed survey. The Project Manager should be involved when designing and recommending the proposed energy retrofits so that they can participate and point out any problems that they foresee during installation. The PM should have prior experience with PC projects as they have to understand how ECMs interact, which ECMs have to be implemented first and how it affects the savings guarantee. The role of the PM in the early stages of the audit process is key as it will allow for a smoother and quicker transition of the project.

The performance monitoring team which monitors the job after installation should also be included in the detailed audit survey, so that they become familiar with the project and the customer. This team should ideally visit the project site on a monthly basis to physically inspect

all the retrofits. Feedback to the audit team is key for success as they can report on the overall performance of the ECMs, how well it stands up to expected energy savings, and any potential problems. Only through continuous communication and feedback can the audit process become better and more effective.

An excellent tool for the monitoring team in setting up monthly savings projection is the simulation package from which savings have been estimated. Instead of projecting a linear fixed savings per month, this tool can specifically identify the interdependency between ECMs and fuel type and generate a monthly predicted utility savings which is a more accurate method for tracking and monitoring energy retrofits. The monitoring team should fully utilize this tool to study savings impact whenever significant modifications are made to the project after installation. Past experience has indicated that savings projection through simulation models have been much superior to other methods, and have proved to be fairly accurate in comparison to actual savings. An Energy Service Company can usually not afford to avoid using some form of simulation packages in predicting energy savings especially when these savings are guaranteed. If manual calculations and vendor provided software packages are utilized in the savings projection of energy retrofits, they should be thoroughly inspected for the validity of the inputs and assumptions. Savings projections from such methods are only as reliable as the validity of the inputs.

SUMMARY

How does "Performance Contracting" projects differ?

1. Guaranteed Savings from energy conservation retrofits
2. Typically, a positive cash flow situation
3. Large liability on part of the energy service company
4. Minimized risk to customers
5. Long-term versus Short-term approach
6. Remote monitoring of facilities
7. Customized comprehensive list of retrofits

How does the Energy Auditing Process differ?

1. In depth study of utility bills to understand how different fuels are utilized and how they impact utility dollars
2. Selection of a utility baseline
3. Thorough understanding how the various processes and equipment operate within a facility, and study their interdependence
4. Detailed metering of equipment to measure exact energy consumption
5. Recommendation of proven technologies to insure conservation measure is successful
6. Identifying a comprehensive list of energy conservation measures
7. Implementing measures that incorporate future benefits to customer
8. Intensive data gathering and analysis process for computer simulation of various energy systems and conservation measures
9. Understanding the interdependence of energy conservation measures

In conclusion, it is very clear that Energy Audits play a very vital and significant role in implementing PC projects. It is compulsory that the energy service company understand how this type of project differs from traditional project approach and therefore accomplish each stage of the project with qualified personnel. The input of the energy audit team is key in understanding the feasibility and success of the overall project from start to finish. Energy Auditing is a very precise, comprehensive, and systematic approach that can be very powerful to the energy service company when utilized in the proper manner.